APPENDIX E

CTP Master Plan for Improvement

TECHNICAL MEMORANDUM

CH2MHILL

CTP Master Plan for Improvements

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1.0 Introduction

1.1 Background

The Central Treatment Plant (CTP) was installed in 1973 by the Bunker Hill Company to treat the combined effluents from the Bunker Hill mine, mill, lead plant, and zinc plant. The four main processing objectives for the CTP were: 1) acceptable effluent quality, 2) minimum sludge production, 3) maximum system reliability, and 4) acceptable capital and operating costs (Baker and Larson, 1973). Twenty-seven years later, the CTP is still treating mine water, and the same four processing objectives still exist.

Acceptable Effluent Quality

In August 2000, EPA and the State of Idaho finalized total maximum daily loads (TMDLs) for the Coeur d'Alene Basin. The TMDLs result in a reduction in the allowable amounts of cadmium, lead, and zinc that may be discharged from the CTP. The current effluent quality will not meet the more stringent TMDL requirements.

EPA and CH2M HILL conducted a treatability program in 1999 and 2000 to determine what process changes were required to meet the TMDL requirements. The program identified two changes: 1) increase the operational pH setpoint to about 9.5 to reduce dissolved metals concentrations, and 2) add tri-media filtration to remove suspended metals.

It is interesting to note that the CTP operated for a period with media filters. These were single media filters installed in 1979 in response to new treatment requirements based on discharge of total metal, rather than only dissolved metal. These new requirements were established in December 1977 and stipulated that compliance be achieved by January 1, 1980. The sand filter system was supplied by G. T. Woods Company and consisted of two rows of 20 filters, for a total of 40 filters. Each filter consisted of a 36-inch-diameter by 8-foot-long steel tank mounted horizontally (laying on its side). These filters were removed from service because of poor performance and high operating costs.

Removal of the filters did not remove the treatment requirements. Rather than using the filters, the operators developed alternative procedures that enabled the plant to meet the discharge limits most of the time by reducing sludge recycle and optimizing clarification.

However, these procedures reduced the ability of the plant to minimize sludge production because a high-density sludge could no longer be produced.

Minimum Sludge Production

When the media filters were removed, the only way the CTP could meet the discharge requirements was by reducing sludge recycle. This reduced suspended metal in the effluent, but had the detrimental effect of producing more sludge. However, at that time the sludge was being pumped to the top of the Central Impoundment Area (CIA), which had considerable storage capacity; thus, there was no motivation to reduce sludge volumes. Although the CTP is still being operated this way, the remaining sludge disposal capacity of the CIA is nearly exhausted.

The CTP treats the mine water using a lime precipitation process. Lime is contacted with the incoming mine water, resulting in precipitation of dissolved metals as sludge. During process evaluation, the Bunker Hill Company realized that disposal of large volumes of low-density sludge would be difficult given the confines of the mountainous terrain of the Kellogg Area (Baker and Larson, 1973). For this reason, a high-density sludge (HDS) process was incorporated into the design of the CTP.

The benefit of the HDS process is that considerably less sludge is produced. Recirculating large quantities of sludge within the treatment process progressively builds sludge particle size. The large size retains less water, enabling the sludge to drain and consolidate much more effectively. The drawback of the HDS process is the requirement to cycle large sludge volumes. This consumes electrical pumping power, requires a larger solids/liquid separation clarifier, and can increase the amount of suspended solids in the plant effluent. It was this last detriment that initiated the requirement to install the media filters. Without filters, too much suspended solids and associated metals were carried into the plant effluent.

Currently, the EPA is in the process of placing a cover system over the CIA to minimize infiltration and metal leaching. The remaining sludge disposal area is expected to be full in 3 to 5 years. Thus, sludge disposal volume is again a significant issue, which is best addressed by minimizing the volume of sludge that must be managed. To achieve this, the CTP must be operated in the HDS mode, which once again requires use of media filters for removal of the suspended metal from the plant effluent. Thus, installation of tri-media filters will allow both attainment of the TMDL, and operation of the CTP in HDS mode.

Maximum System Reliability

During CTP process development and design, the Bunker Hill Company acknowledged the potential for the CTP to experience upsets and breakdown, as summarized in the following statement: “The central impoundment pond will provide surge holding capacity during treatment plant upsets or breakdowns, thereby protecting the quality of the river course at all times” (Baker and Larson, 1973).

With the installation of the cover system, the CIA can no longer be used for mine water storage as done by the Bunker Hill Company. Thus, to provide protection from CTP upsets or breakdowns, either replacement storage is needed, more backup and redundant

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treatment capability is needed, or both. Use of both is expected to be more protective and cost-effective.

This CTP master plan describes recommended CTP modifications to cost-effectively reduce upsets or breakdowns. When coupled with emergency in-mine storage and storage provided by the lined pond, the likelihood of discharge of untreated mine water is considerably reduced.

Acceptable Capital and Operating Costs

Today, as was the case 27 years ago, lime neutralization is still the most cost-effective way to treat the mine water. Use of the HDS process is also the most cost-effective way to reduce sludge volumes. Use of tri-media filters and a pH setpoint of about 9.5 is the most cost-effective way to meet the TMDL treatment requirements. Maximizing use of existing CTP equipment and infrastructure to the most practical extent possible will minimize the cost to upgrade the CTP for compliance with the TMDL, minimize sludge production, and provide reliable treatment.

1.2 Objectives of the CTP Master Plan

The objectives of this CTP master plan are to describe changes needed to do the following:

1) Provide acceptable effluent quality that is compliant with the TMDL
2) Minimize sludge production
3) Maximize system reliability
4) Provide acceptable capital and operating costs

This plan does not provide detailed engineering design, but instead focuses on the types of changes needed and where the new equipment and facilities should be located. Section 2 describes a phased approach for these changes.

2.0 Phased Approach

Three phases have been developed for upgrading the CTP. These phases allow the improvements to be done around the existing equipment and operations, both to minimize plant down time and to use existing equipment to the maximum extent practicable. The changes described in Phase 1 are necessary to most cost-effectively meet the requirements of the TMDL, minimize sludge volume, and maximize system reliability. The changes described in Phase 2 are only needed if the CTP capacity must be greater than 2,500 gpm. The changes described in Phase 3 are only needed if mechanical sludge dewatering is needed for offsite sludge disposal.

Phase 1 consists of modernizing the CTP to reliably meet the TMDL requirements and produce HDS at a capacity of 2,500 gpm. It will be constructed while the existing unit processes are still operating to the maximum extent reasonable. A total shutdown of about 4 to 5 weeks is anticipated so the sludge thickener can be taken out of service for overhaul. Some of the current CTP components will remain in place after Phase 1 construction is complete; however, they will be placed in standby mode to provide backup and redundant service.

Completion of Phase 1 improvements under the master plan eliminates the need for active operation of the existing aeration basin (Reactor B), Reactor A, and floc tank. The Phase 1 upgrades would allow the existing finished water reservoir (polishing pond) to be permanently removed from service. The area made available can be used for other purposes and for Phase 2 improvements.

Phase 2 would be done if additional treatment capacity were needed, and in this master plan consists of adding additional equipment to treat up to 5,000 gpm of AMD. This would involve removal of the existing aeration basin, adding a second neutralization/oxidation treatment reactor, and adding additional filters.

Phase 3 would be initiated if mechanical sludge dewatering and offsite disposal were implemented. This would involve adding a sludge dewatering system and building.

3.0 Influent Design Conditions for Upgraded CTP

The influent design conditions for the upgraded treatment plant are shown in Table 1. During Phase 1 the CTP will be sized to hydraulically pass and neutralize 5,000 gpm, but HDS production and filtration capacity will be sized at only 2,500 gpm. Initially constructing a 5,000 gpm hydraulic throughput capacity will add little cost, but will provide considerable savings if Phase 2 is implemented because a retrofit would be avoided. Providing for sufficient lime feed capacity for 5,000 gpm for both phases provides lime feed redundancy at all but the peak flows, and assures that large flows and/or lime demands can be neutralized, thus preventing the release of high metal concentration acid water. As can be seen in Table 1, there is a large peaking factor that must be handled in the design of the upgraded CTP, even in Phase 1.

4.0 Description of Existing Facility and Recommended Phase 1 Improvements

The CTP was originally designed and operated as a HDS plant as described earlier. In the HDS mode, lime slurry is added to recirculated thickened sludge in the sludge conditioning reactor (Reactor A), which is then contacted with the plant influent in the neutralization/oxidation reactor (Reactor B). This reactor overflows to a polymer addition/flocculation chamber, which overflows to the thickener. However, the plant is currently operated in a mode of inadequate sludge recycle and inventory in the thickener to achieve thickened sludge concentrations necessary to produce HDS. Over the years the operators have found that, given the lack of effluent filters and the available infrastructure, operation in this low-density sludge (LDS) mode produces better effluent quality than operation in the HDS mode. However, the LDS mode produces about three times the volume of sludge as the HDS mode. Figure 1 shows the present facility layout (all tables and figures follow the text).

The following sections provide descriptions of the major components of the existing CTP, their current shortcomings, and recommended Phase 1improvements. Figure 2 shows the

Phase 1 CTP additions and modifications, and Figure 3 is a process flow diagram of the CTP after Phase 1 improvements. Table 2 summarizes preliminary equipment sizes.

4.1 Lined Pond and Pump Station

Description

All influent to the CTP (including the mine water) currently comes from the lined pond, which has 7 million gallons of storage capacity. A pump station pumps the pond contents to the CTP. The quiescent water conditions in the pond promote deposition of muck that settles from the mine water. This is a serious problem that must be remedied or the pond will become unusable. About 2 million gallons of muck has accumulated since the pond became fully operational in May 1996. The lined pond pump station is equipped with three identical pumps that are used to deliver flows from the lined pond to the CTP. Either one or two of the pumps are constantly used to pump from the lined pond to the CTP. In general, the pump station components are relatively new and work well.

Shortcomings

It is estimated that about 450,000 gallons per year of muck is accumulating in the lined pond. This reduces its capacity for holding mine water, and will eventually require costly removal. This accumulation will continue as long as the mine water is deposited into the pond.

The pump station pumps can now be controlled remotely from the CTP control room; however, there is currently no provision for monitoring the water level in the lined pond. There also are no alarms at the CTP to alert the operators of a pump station problem.

Recommended Phase 1 Improvements

Bypass piping around the lined pond is needed if the pump station is inoperative. This bypass piping would also allow mine water to be routinely piped directly to the CTP by gravity, which reduces maintenance and wear of the pump station, reduces electrical power used for pumping, and reduces the deposition of mine muck in the lined pond that is costly to remove.

The water level in the lined pond should be displayed at the CTP so the operators can track and better manage its volume. The run status of each of the pump station pumps should also be displayed at the CTP, in addition to automatic alarms to alert the operators if the pumps become inoperative or if the pond is becoming full.

4.2 Lime Feed System

Description

The CTP uses lime slurry to neutralize the acidity of the influent and to precipitate the dissolved metals. The CTP uses hydrated lime rather than quicklime because the CTP does not have an operational lime slaker. The following describes how lime slurry is currently semi-manually produced and fed into the treatment process at the CTP.

1. Lime (hydrated lime) is pneumatically transferred from the delivery trucks into the single 200-ton storage silo.

2. An operator turns on a water aspirator system (eductor) that induces a vacuum below the cone of the silo, which in turn pulls lime out of the silo and into the water stream. The water source is plant effluent pumped from the polishing basin.
3. The aspirated lime / water mixture discharges into a sump cut in the floor at the base of the dysfunctional lime slaker.
4. An operator sits next to the sump and manually varies the amount of dilution water added to the sump, using a water wand to prevent the sump from becoming clogged.
5. A sump pump pumps the slurry out of the sump into an adjacent lime slurry storage tank.
6. One of two slurry pumps continually pumps lime slurry out of the bottom of the tank, through a lime slurry loop, and then back into the top of the tank.
7. An automatic valve on the lime slurry loop opens in response to a signal sent from a pH probe in the aeration basin effluent to divert lime slurry from the loop into the treatment process at the sludge conditioning reactor (Reactor A).
8. An operator makes a new batch of lime once the level of the lime slurry in the storage tank drops below a predetermined level.

Shortcomings

The economics of lime usage favor the use of pebble quicklime rather than hydrated lime (about a 40 percent savings), slaking at the treatment plant to form hydrated lime, and then automatic slurring and feeding of the hydrated lime into the treatment process. Automatic slaking, slurrying, and feeding are usually performed because the initial capital cost of the equipment is recuperated in labor savings. For these reasons, the CTP initially used quicklime and a slaker for lime slurry preparation. The slaker is currently inoperative and is no longer used. The less-efficient and more costly semi-manual makeup system is used instead.

Without the ability to make and use lime slurry, the CTP cannot function. The current lime makeup and feed system lacks redundancy. Failure of the single lime storage silo, single aspirator system, and single lime slurry tank mixer would shut down the CTP. Also, it is unlikely that the semi-manual lime slurry makeup system could keep up with high lime demands resulting from very high mine water flows.

There are no functioning indicators or alarms to alert the operators of lime makeup or feed problems, other than loss of treatment process pH control, which is too late to prevent process upsets. The current method of pH measurement, coupled with the too large retention time in Reactor A and the poor mixing in Reactor B, results in the inability to control process pH in Reactor B more accurately than one-half a pH unit. Finer pH control would result in more consistent lime feeding and treatment.

Recommended Phase 1 Improvements

The CTP will continue to use lime slurry to neutralize the AMD acidity and to precipitate the dissolved metals. Hydrated lime, which is more expensive than quicklime, is currently used because there is no operational lime slaking system. The present method of lime preparation is also labor-intensive and presents a potential safety hazard, requiring the use of respirators. It also produces lime slurry with potentially high variability in concentration.

Previous analysis has shown that, at the average usage rates for the CTP, (unhydrated) pebble quicklime is more cost-effective than hydrated lime. The payback period accounting for both labor and lime cost reduction is estimated at 1.5 years. This assumes that four hours of labor per day is saved or devoted to some other activity that is currently consuming labor hours, such as plant maintenance.

The entire CTP would need to be shut down if the existing lime make-up system were to malfunction for more than a day, because there are no redundancies. In addition, it is unlikely that the existing lime system can deliver the peak lime demand. For these reasons, during Phase 1 a new lime silo, slaking, slurry transfer and storage, and feed system will be installed. This will allow the existing lime system to be taken off-line and upgraded by adding a new slaker system, which will result in redundant lime preparation and feed systems. The new silo and slaker will be located along the access road east of the existing silo (see Figure 2). The new lime slurry tank will be located further east than the silo.

The existing silo appears to be in good condition and will be cleaned out and retained. The new slaker will allow the existing system to use quicklime as well. New slurry transfer pumps and piping will be installed. The lime slurry tank and mixer also appear to be in sound condition and of adequate size for future use. They will also be cleaned, reconditioned, and reused.

New lime slurry recirculation pumps will be installed to transfer the lime through a redundant set of looped piping to Reactor A. High velocities will be maintained in the lime system to minimize scaling of the pipe walls.

The two independent lime slurry delivery systems will be different sizes to accommodate a wide range of influent lime demands. A smaller system will be used during average flow, with the large system available as standby and for peak demand periods.

4.3 Sludge Conditioning Reactor (Reactor A)

Description

The sludge conditioning reactor (Reactor A) is used to contact the recycled sludge with lime slurry to produce lime-coated sludge particles, which are in turn added into the feed launder of the aeration basin. Reactor A is made of steel and is listed as having a volume of 15,000 gallons. The reactor has four baffles. A mixer provides agitation. Visual inspection indicated good mixing. The discharge consists of an overflow box, which is about four feet from where the recycle sludge pipeline introduces sludge. The recycle sludge is discharged vertically into the top of the tank.

Shortcomings

The tank is too large to serve as an efficient sludge conditioning reactor. The long detention time causes too much lime to be added before the pH in Reactor B responds, contributing to pH swings. When the pH in Reactor B reaches a high set point, the lime-treated solids inventory in Reactor A continues to enter Reactor B, even though no more lime is added. This causes about a 0.5 pH unit swing in Reactor B.

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Recommended Phase 1 Improvements

The existing Reactor A will be replaced by a new Reactor A, with a capacity of about 2,500 gallons. A smaller reactor will allow better response time for pH control, avoiding the pH swings inherent in the existing system. It will also be easier to clean out. Lime and recycled sludge will be mixed in this tank using a small mixer. The tank will be located such that the lime-coated sludge will flow by gravity either to the old aeration basin (old Reactor B) or to the new aeration tank (new Reactor B). Experience has proven that there is no need for a redundant Reactor A, because even if the mixer breaks, there is enough turbulence induced by flow into the small tank for mixing to be adequate until repairs can be made.

4.4 Aeration Basin (Reactor B)

Description

The pumped influent from the lined pond enters the CTP on the west end of the aeration basin (Reactor B). The aeration basin has a platform-mounted 50-hp slow-speed surface aerator/mixer. The aeration basin is lined with a 60-mil high-density polyethylene (HDPE) liner, which was installed in 1994. The basin is designed to be 10 feet deep, with a floor measuring 50 feet by 60 feet with 1-1/2:1 side slopes. The design volume is approximately 370,000 gallons. The CTP operator reported that, in the past, the basin would be periodically cleaned of accumulated sludge using a backhoe, but now that it has been lined this is not feasible. A 4-inch-diameter pipe was installed to remove solids from the basin using Sludge Pump No. 1, but this is not effective.

Shortcomings

The existing aerating basin and platform-mounted splashing aerator are inefficient, prone to short-circuiting, and are incapable of maintaining solids in suspension. The mixer provides good agitation at the center of the basin, but poor mixing in the rest of the basin. The central location and radial flow creates short-circuiting around the basin sides. The basin is nearly full of sludge, except within about a 10- to 20-foot radius of the mixer. If higher-density solids were fed to Reactor B, even more deposition would occur. The current sludge build-up problem will be compounded when the plant is run in HDS mode. Also, there is currently no redundancy; if this reactor were to shut down, or if the mixer were to fail, the CTP would have to be shut down.

Recommended Phase 1 Improvements

These shortcomings will be corrected by adding a new, 75,000-gallon mixed and aerated steel reactor between the existing filter building and the existing aeration basin. A retaining wall will be built to allow adequate room for the new tank. The new Reactor B will be configured to operate in parallel with the aeration basin, which would serve as a backup. The new reactor will be baffled and equipped with a submerged turbine aerator/mixer to keep the contents completely mixed and to supply aeration for the oxidation of reduced iron and manganese. This is the configuration installed at the Iron Mountain Mine Superfund site in California, and it is producing excellent results. The existing aeration basin will be cleaned out and decommissioned, but left in place as a backup to the new reactor.

4.5 Flocculation Basin

Description

The aeration basin discharges into a flocculation chamber through a discharge launder. The flocculation chamber is located between the aeration basin and the thickener. The flocculation basin was originally intended to flocculate the feed to the thickener using a flocculent aid (polymer). The flocculation chamber measures 32 feet wide, 32 feet long, and 12 feet deep, and is completely full of sludge. This equates to a liquid volume of 88,000 gallons. A 1.5-hp motor had been used to rotate a flocculation paddle, which has been shut off.

Shortcomings

The flocculation basin is no longer used. The mixer has been shut off because mixing was insufficient to prevent solids deposition. Polymer is being added into the discharge launder from the flocculation basin just prior to the pipe leading to the thickener center well. This point of polymer addition has been empirically found to provide better results than addition before the flocculation basin.

Recommended Phase 1 Improvements

The flocculation chamber no longer serves any useful purpose and will be cleaned out and decommissioned, but left in place in case the aeration basin is operated. The discharge from the new Reactor B will flow through a new pipeline into the center well of the thickener. A new polymer feed system will be configured so flocculent can be added either into the pipeline, at the center well, or both.

4.6 Polymer Make-up and Feed System

Description

Polymer solution is currently manually made up by adding dry polymer to water in a polymer make-up tank. Two side-mounted mixers are used for mixing. A transfer pump, operated on a level switch, is used to transfer polymer solution from the make-up tank to a polymer feed tank. A small variable speed pump is used to pump polymer from the feed tank to the discharge launder of the flocculation chamber, where the polymer mixes with the thickener feed. Polymer dosage is evaluated by observing the settling rate of samples of thickener feed and effluent turbidity, and is adjusted by changing the speed of the feed pump.

Shortcomings

The current manual make-up system is labor-intensive. There are no alarms to alert the operators of problems, or if the polymer storage tanks are getting low.

Recommended Phase 1 Improvements

A new polymer make-up and feed system will be installed. An automated polymer make-up and feed system would reduce manpower requirements, allow more efficient use of polymer (fewer fisheyes), and increase worker safety. This system will be located inside the existing building.

4.7 Thickener

Description

The discharge from the flocculation chamber enters a 24-inch-diameter pipe and is carried to the center of the thickener, where it discharges into a 20-foot-diameter center well that rotates with the rake. Discharge from the center well into the thickener is through six rectangular ports that are approximately 6 feet below the surface. The thickener is 236 feet in diameter and was supplied by Eimco Process Equipment Company, now Baker Process. The thickener has a concrete bottom and a steel side wall. The water depth is 10 feet on the side. The bottom slopes at a 1 in 12 slope from the side wall to within 50 feet of the center, where the slope steepens to 2 in 12. The center well depth is 27.67 feet. The thickener volume is 4.4 million gallons.

The purpose of the thickener is to separate the sludge from the treated water by gravity settling, and also to thicken the settled sludge to remove water to create less sludge volume. Settled sludge is scraped into the center by the thickener rake mechanism and pumped via sludge recycle pumps to the sludge conditioning reactor (Reactor A). Periodically, usually daily when the plant is operating, sludge is wasted to the sludge basin (formally referred to as the decant pond) located on top of the CIA.

It appears that very little solids actually settle near the perimeter of the thickener, because the bottom of the thickener is clearly visible near the wall. Most solids deposition occurs near the center well. Typically, clear effluent with low suspended solids (between 1 and 6 mg/L) leaves the thickener. Some pin floc has been observed near the wall, indicating that almost the entire area of the thickener is used to clarify the treated water.

It has been empirically found over years of operation that the LDS mode of operation produces the best effluent quality in the absence of effluent filtration. Given the large disposal area previously provided by the CIA, there has historically been no impetus to concentrate wasted sludge solids, so the thickener is currently being operated primarily as a clarifier and not up to its full potential as a thickener. The CTP was operated in the HDS mode for a portion of 1997. During that time, the effluent total suspended solids (TSS) was observed to increase. This increase was correlated with higher feed solid loadings. Higher feed mass loading results from increases in recycle ratio and/or increases in underflow solids concentration. The optimal TSS removal was found to occur when the thickener feed solids concentration (including recycle) was less than 1 percent (wt %). Higher feed solids load also affects the polymer dosage, as measured by mg/lb dry solids in feed. It appears the higher TSS is a result of decreased effectiveness of the polymer because of either reduced dosage when operating in the HDS mode, or reduced mixing effectiveness of polymer and solids.

In the LDS mode, an amount of sludge sufficient to permit a high degree of thickening as a result of sludge compression is not allowed to build up. This is evidenced by the fact that the solids of samples from thickener underflow left standing for several days will settle to roughly 30 percent of their original volume (CH2M HILL, 1997). However, the LDS mode of operation is required to meet the current discharge limitations because no filters are available to filter out the higher levels of suspended solids that overflow the thickener weir during operation in the HDS mode.

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Clarified effluent is discharged radially from the top of the thickener into the perimeter effluent launder, where it flows to a discharge pipe located at the end of the bridge walkway. This pipe conveys the effluent into the polishing basin.

Shortcomings

Although the thickener is nearly 30 years old, it appears to be in relatively good structural condition. The thickener drive head (model number C84B2P) was replaced in June 1994. Eimco (now Baker Process) in Salt Lake City was contacted about the capability of the mechanism to handle a denser sludge. They said that because the mechanism does not have a rake lift, it should have sufficient torque to operate on sludge of between 20 and 30 wt %. They recommended that a rake-lifting device be installed for use on sludge of greater than 30 wt %. A rake lift will not be needed because the underflow sludge will be kept between 20 and 30 wt % during HDS operation.

Recommended Phase 1 Improvements

The thickener will need to be taken out of service and rehabilitated. This would include emptying, sandblast and repair, repaint inside and out, cure, repair and replace thickener rakes, make center well modifications, and test and make adjustments, followed by startup. A shallow groundwater investigation will be needed prior to emptying to determine if groundwater drawdown is needed to prevent buckling of the thickener floor. The weir plates should be replaced with new plates of a V-notch design that would provide a more uniform overflow around the circumference of the thickener.

The estimated duration of the overhaul is 4 to 5 weeks, during which the CTP will be shut down. This down time could be reduced by fast-track construction, working around the clock. During the shutdown, the AMD will need to be stored in the mine and lined pond, necessitating close coordination with the mine owner. During this same shutdown period, other Phase 1 tie-ins to the existing treatment system will be made.

4.8 Polishing Pond

Description

The polishing pond is a concrete trapezoidal basin located between the thickener and Bunker Creek. There are several feet of sludge solids in the basin, which reportedly has never been cleaned. The basin was originally intended to be a reservoir for recycling water back to the ore concentrator, which no longer exists. Water is still pumped from the polishing basin for use as lime slurry make-up water. Treated water from the thickener enters the basin on the northeast corner. Water flows across the basin to the southwest corner, where it is discharged through a 12-inch Parshall flume into Bunker Creek at Outfall 006.

Shortcomings

An unknown amount of water is leaking through the construction joints of the walls as evidenced by drips and the presence of green plants at the joints. The basin is larger than needed to supply lime slurry make-up water, and takes up space needed for the new filter system. The sludge within the basin is prone to disturbance and subsequent carryover into Bunker Creek.

Recommended Phase 1 Improvements

A treated water supply tank will replace the polishing basin. The tank will be considerably smaller and take up much less space. This tank will receive filtered effluent from the filter system, which will be used for filter backwash, lime slurrying, wash water, and pump cooling. City water will be used for lime slaking, drinking, and other needs that require a low total dissolved solids (TDS) water. Recycled effluent could also be used for lime slaking in the event of a City supply failure. Excess water, which overflows the top of the tank, would discharge through a flow-measuring device to Bunker Creek.

4.9 Sludge Recycle and Wasting Pumps

Description

Three sludge recycle and wasting pumps are located in the control room, which is adjacent to the thickener. Two pumps (Pumps 1 and 2) are currently used for sludge recirculation, and two pumps (Pumps 1 and 3) are used for wasting. Two steel sludge recirculation lines are available. One is an 8-inch outside diameter (O.D.) and the other is a 10-inch O.D.

Sludge is generally pumped (wasted) into the CIA sludge disposal area for one to two hours per day, until the underflow slurry reaches a targeted specific gravity of typically 1.03 to 1.06. The target specific gravity is temperature-dependent and has been determined by empirical observation by the operators to achieve good treatment performance, indicated primarily by low suspended solids in the effluent.

Shortcomings The existing sludge recycle and waste pumps are original equipment. Although they are still functional, they are worn and need overhaul or replacement.

Recommended Phase 1 Improvements

The existing sludge recycle and wasting pumps will be overhauled or replaced. Additional pumps will be used to provide flow rate flexibility and redundancy. Up to four recycle and up to two waste pumps may be used.

4.10 Control System

Description

The CTP uses the original panel-mounted process control devices installed in 1974. Most of the antiquated process controls no longer function. Other than pH control and annunciation of certain alarms, there is no automation in the existing control system. Paper for the strip chart recorders is no longer manufactured.

Shortcomings

The existing system does not have the flexibility and capability to support new equipment. The system is non-computerized and inefficient. A modern system would be considerably more reliable, efficient, and flexible.

Recommended Phase 1 Improvements

A new automated programmable logic controller- (PLC) based system is recommended. This system would automatically monitor system performance, control all pumps and mixers, automatically initiate lime and polymer make-up, record vital record-keeping information (such as flow and effluent metal load), and provide AutoDial alarm functions when needed. The control system will allow the plant to run unassisted overnight or on weekends, depending on the degree of autonomy desired.

A new personal computer will serve as the human-machine interface (HMI). The operator can view each unit process on the computer screen and know the status immediately. Software changes can also be made using the HMI. The HMI can be assessed both at the plant and remotely, and can provide automated reports. This system would also track river flow at the Pinehurst gauge, enabling daily automatic calculations required to determine discharge quantity for complying with TMDL requirements.

4.11 Control Building

Description

The control building houses the existing polymer make-up system, sludge recycle and control pumps, electrical gear, and control system. It also contains a small bathroom with toilet and sink, a small desk, and storage cabinets.

Shortcomings

The control building is too small to accommodate additional pumps, the polymer system, and the new control room.

Recommended Phase 1 Improvements

The control building should be enlarged. It was assumed that the new building addition would be approximately 600 square feet, approximately double the size of the existing building. The new pumps will be located in the existing control room. The area occupied by the current polymer system will be used for spare parts storage and will perhaps continue to be used to house the finished polymer solution tank. If desired, additional space could be added for an operator break room, small laboratory, and office.

4.12 Add Tri-Media Filtration of CTP Effluent

As discussed earlier, tri-media filters are required for compliance with the TMDL discharge requirements, and for operating in the HDS mode. The headroom of the present building is inadequate for the new filters. Vertical pressure filtration vessels will be installed inside a new building located at the current site of the old filter building, which will be removed and possibly reused elsewhere onsite for spare parts storage. These types of filters are expected to work much more efficiently than the old horizontally configured filters previously discarded.

A new wet well and pump station will intercept flow from the thickener launder heading to the finished water reservoir. The pump station will pressurize up to 2,500 gpm through piping into the filter building. Flows greater than 2,500 gpm will overflow through a pipe from the wet well into Bunker Creek. The pressurized influent to the filters passes through a gallery to filters located on both sides of the building. Individual pipes will carry a portion of the flow into individual pressure vessels. The flow is distributed uniformly and passes into the media. Filtered wastewater passes out of the media bed and into an under-drain, where it is collected and routed out of the pressure vessel. The accumulated filtered water passes out of the building and into a backwash supply tank. Excess water overflows the outlet on top of the tank through a flow-measuring device to Bunker Creek. This tank will also supply lime slurry make-up water. Following completion of Phase 1, the polishing pond will no longer receive flow and can be removed from service.

As solids are captured in the media bed, pressure loss increases at a given flow rate. The bed is regenerated by backwashing, when a high flow rate of water is applied to the bed in a turbulent, upflow fashion to remove the solids. An air scour system may also be installed to assist with backwashing. Backwash water will be supplied from the backwash supply tank. Dirty backwash water will be collected in a mixed tank and bled at a slow uniform rate back to the treatment plant inlet.

4.13 Other Recommended Phase 1 Improvements

Other recommended Phase 1 improvements are listed below.

Backup Power System. The current CTP has no backup power system. Loss of power supply results in plant shutdown. A diesel generator and fuel storage tank will be added to provide backup power to critical plant components. This system will start automatically if the main power system shuts down.

Influent Flow Meter. There is currently not an adequate way to measure the influent flow to the CTP. An old venturi type meter operating on a differential pressure concept was originally installed but is no longer operational. Currently, the CTP inflow rate is estimated empirically based on valve settings, or by using the Outfall 006 flume. Accurate inflow rate information is needed to determine plant operating conditions, track chemical consumption, and evaluate plant performance for daily compliance with TMDL requirements. A new magnetic flow meter will be added to accurately measure the incoming flow.

Sulfide Feed System or Filter Feed Flocculent System. The treatability testing program showed that additional metal could be removed from the effluent by either adding sulfide into the effluent of Reactor B, or by adding flocculent prior to the filters. Although these systems are not expected to be needed for compliance with the TMDL, consideration will be given for future addition if they become desirable.

5.0 Phase 2 Improvements

Phase 2 improvements are needed only if more than 2,500 gpm must be treated. Figure 4 shows the CTP configured for Phase 2, and Figure 5 shows a process flow diagram. Phase 2 improvements would include the following:

- Removal of the existing Reactor A, aeration basin, flocculation basin and associated equipment and piping
- Re-grading the area previously occupied by these facilities
- Installing a second Reactor B in the area previously occupied by these facilities
- Modifying Reactor A to provide capability to feed both B reactors

- Piping work to allow the B reactors to operate in series or parallel, and for flow to the thickener center well
- Add or modify the sludge recycle pumps to increase the solids recirculation ratio
- Add additional filtration capability and expand the filtration building.

The addition of the above equipment will allow the system to process 5,000 gpm at the influent conditions shown in Table 1.

6.0 Phase 3 Improvements

Phase 3 improvements are needed only if it is decided to mechanically dewater the sludge for offsite disposal. This would consist of the following:

- Demolition and regrading of the polishing pond if not already done
- Installation of sludge dewatering facilities inside a new building on the site previously occupied by the polishing pond

TABLE 1
Bunker Hill CTP Influent Design Conditions
Bunker Hill CTP Master Plan

Parameter	(Units)	Maximum Design	Typical Design[1]
AMD Hydraulic Throughput and Neutralization Capacity	gpm	5,000 (both phases)	1,500 (both phases)
Filtration Capacity	gpm	2,500 (Phase 1) 5,000 (Phase 2)	1,500 (both phases)
pH	Units	2.0	3.1
Lime Demand (Calcium Hydroxide)	lb/1,000 gal	80.0	10
Solids Formed	lb/1,000 gal	130	12.5
Dissolved Ferrous Iron	mg/L	200	41
Manganese	mg/L	400	130
Sulfate	mg/L	7,000	1,900
TSS	mg/L	600	170
TDS	mg/L	11,000	3,000

[1]Average chemistry is based on Kellogg Tunnel discharge data from 1998/1999 monitoring program. Average flow is based on historical data between 1972 and 1999.

NOTE: lb/1,000 gal = pounds per 1,000 gallons
mg/L = milligrams per liter

TABLE 2
Preliminary Equipment Sizing
Bunker Hill CTP Master Plan

		Average Flow		Peak Flow	
	Units	**Normal Concentration**	**Peak Concentration**	**Normal Concentration**	**Peak Concentration**
Preliminary Design HDS Solids Recycle Ratio					
Phase 1	solids recycled/ solids formed	50	20	50	12
Phase 2	solids recycled/ solids formed	50	20	50	9.5
Reactor A (Sludge Conditioning)					
Number		1	1	1	1
Size (each)	gallons	2,500	2,500	2,500	2,500
Reactor B (Neutralization and Oxidation)					
Phase 1 Number		1	1	1	1
Phase 1 Size (each)	gallons	75,000	75,000	75,000	75,000
Phase 2 Number		1	2	1	2
Phase 2 Size	gallons	75,000	75,000	75,000	75,000
Estimated Solids Recycle Flows and Pump Sizes					
Phase 1 Flows	gpm	400	1,500	600	1,500
Phase 1 Pump Sizes		(2) 400 gpm and (2) 800 gpm			
Phase 2 Flows	gpm	400	1,500	1,200	2,400
Estimated Sludge Wasting Flows and Pump Sizes					
Phase 1 Volume Wasted	gal/day	10,500	110,000	18,000	183,000
Phase 2 Volume Wasted	gal/day	10,500	110,000	35,000	370,000
Preliminary Lime Systems					
Phase 1 Estimated Lime Use	Tons (as CAO)/day	8.6	69	14	115
Phase 2 Estimated Lime Use	Tons (as CAO)/day	8.6	69	29	230
Phase 1 Lime Slurry Feed Rate	gpm	17	140	30	230
Phase 2 Lime Slurry Feed Rate	gpm	17	140	60	450
Number of Slakers (Same for both Phase 1 and 2)		2	2	2	2

NEXT

TABLE 2
Preliminary Equipment Sizing
Bunker Hill CTP Master Plan

		Average Flow		Peak Flow	
	Units	**Normal Concentration**	**Peak Concentration**	**Normal Concentration**	**Peak Concentration**
Granular Media Effluent Filtration System					
Phase 1 and 2 Filter Sizing	gpm/sf	4	4	4	4
Phase 1 Number of 12-ft-Diameter Filters Operational		4	4	6	6
Phase 2 Number of 12-ft-Diameter Filters Operational		4	4	12	12